FORM PTO-1390
REV. 5-93

US DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEYS DOCKET NUMBER
P01,0114

U.S.APPLICATION NO. (if known, see 37 CFR 1.5)
09/913311

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/00314	2 February 2000	25 February 1999

TITLE OF INVENTION
"DEVICE FOR FITTING SUBSTRATES WITH ELECTRICAL COMPONENTS"

APPLICANT(S) FOR DO/EO/US
Ralf SCHULZ and Mohammad MEHDIANPOUR

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C.371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report)**.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☒ A substitute specification and a marked up version of the specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    a. ☒ Submittal of Drawings
    b. ☒ **EXPRESS MAIL #EJ 552525890 US, dated August 9, 2001.**

U.S.APPLICATION NO. (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/913311	PCT/DE00/00314	P01,0114

519 Rec'd PCT/PTO 10 AUG 2001

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):		
Search Report has been prepared by the EPO or JPO $860.00		
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) $700.00		
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $770.00		
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO $1040.00		
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... $ 96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	

Claims	Number Filed		Number Extra	Rate		
Total Claims	18	- 20 =		X $ 18.00	$ .00	
Independent Claims	1	- 3 =		X $ 80.00	$	
Multiple Dependent Claims				$270.00 +	$	
				TOTAL OF ABOVE CALCULATIONS =	$ 860.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)					$	
				SUBTOTAL =	$ 860.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					$	
				TOTAL NATIONAL FEE =	$ 860.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +						
				TOTAL FEES ENCLOSED =	$ 860.00	
				Amount to be refunded	$	
				charged	$	

a. ☒ A check in the amount of $ 860.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **501519**. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY – CHAPTER II

AMENDMENT "A" PRIOR TO ACTION AND SUBMISSION OF SUBSTITUTE SPECIFICATION

APPLICANT(S):	SCHULZ, R., et al.
ATTORNEY DOCKET NO:	P01,0114
INTERNATIONAL APPLICATION NO:	PCT/DE00/00314
INTERNATIONAL FILING DATE:	02 FEB 2000
INVENTION:	DEVICE FOR FITTING SUBSTRATES WITH ELECTRICAL COMPONENTS

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Applicants herewith submit an amendment and substitute specification in the captioned PCT application, and respectfully request entry of same prior to examination in the United States National Stage.

IN THE SPECIFICATION

Cancel the specification as filed, and insert therefore the substitute specification provided herewith.

IN THE CLAIMS

Cancel claims 1 - 18 as filed, and insert therefore new claims 19 - 36 as follows:

- - 19. (New) An apparatus for equipping a substrate with electrical components, the apparatus comprising:

a movable fitting head for handling said components, said fitting head having a transfer station, a stator, a pivoting element, at least one gripper, and at least one

storage element including a plurality of storage spaces for said components;

said at least one gripper having a holding end capable of picking up said components at feed devices and transporting and placing said components to fitting locations on said substrate; and

said at least one storage element being separate from said at least one gripper and movable relative thereto along with said plurality of storage spaces, whereby components picked up by said at least one gripper can be deposited at said plurality of storage spaces of said at least one storage element such that the deposited components can be removed from said plurality of storage spaces via said at least one gripper and placed onto said substrate.

20. (New) An apparatus according to claim 19, wherein said components are fixed at said holding end of said at least one gripper, said holding end being movable transversely with respect to a placement direction of said components into a transfer position assigned to said transfer station on said fitting head, and said plurality of storage spaces in said fitting head being successively displaced to said transfer station.

21. (New) An apparatus according to claim 20, wherein said at least one gripper is mounted on said pivoting element of said fitting head, and said holding end is pivotable transversely, with respect to the placement direction, between a placement station and said transfer station via the pivoting element.

22. (New) An apparatus according to claim 21, wherein said at least one gripper is mounted in a guide in said pivoting element, such that said at least one

gripper is displaceable longitudinally in the placement direction.

23. (New) An apparatus according to claim 22, wherein said holding end in said transfer station is displaceable longitudinally in a direction relative to one of said plurality of storage spaces.

24. (New) An apparatus according to claim 20, wherein said at least one gripper is a suction device, and a pressure condition in said suction device in the transfer position is controlled such that a holding force is greater that or less than a holding force exerted by one of said plurality of storage spaces.

25. (New) An apparatus according to claim 20, wherein said plurality of storage spaces are distributed in a grid-like fashion on a sliding part mounted on said fitting head, said sliding part being displaceable in a step-by-step fashion, such that when said sliding part is displaced, said plurality of storage spaces are displaced successively relative to said transfer station.

26. (New) An apparatus according to claim 25, wherein said sliding part is provided with suction openings for said components.

27. (New) An apparatus according to claim 26, wherein said suction openings are permanently connected to a common suction line.

28. (New) An apparatus according to claim 27, wherein said at least one storage element is provided with means for changing the pressure condition in said

suction devices.

29. (New) An apparatus according to claim 10, wherein said sliding part is of annular design and rotatably mounted.

30. (New) An apparatus according to claim 29, wherein the axis of rotation of said sliding part is congruent with the longitudinal axis of said at least one gripper located in the placement position, and said plurality of storage spaces have supporting surfaces extending perpendicularly to the longitudinal axis of said at least one gripper.

31. (New) An apparatus according to claim 30, wherein said pivoting element is provided with a plurality of guides for cooperation with said at least one gripper, and said plurality of guides can be pivoted successively into the transfer position.

32. (New) An apparatus according to claim 31, wherein said pivoting element comprises, two holders, each having longitudinal axes forming a V shape with respect to each other in a pivoting plane, such that said holders are alternatively pivotable into the placement position in which a respective one of said holders is in the transfer position.

33. (New) An apparatus according to claim 31, wherein said pivoting element is constructed as a turret-like rotor having a multiplicity of circularly arranged

grabbers, and in that the rotor can be driven and indexed in accordance with the angular pitch of said grabbers.

34. (New) An apparatus according to claim 33, wherein a plurality of working stations are provided along a circulation path of said grabbers and said stator of said fitting head, and at least one of said working stations forms said transfer station of said fitting head.

35. (New) An apparatus according to claim 34, wherein, in the direction of rotation of said rotor, between said transfer station and said placement station, a sensing station is disposed for determining the position of said components and a rotation station for said components.

36. (New) An apparatus according to claim 35, wherein said fitting head has one storage element, assigned to a transfer station. - -

IN THE ABSTRACT

Cancel the Abstract as filed, and insert therefore on a separate page, the following Abstract of the Disclosure:

- - **ABSTRACT OF THE DISCLOSURE**

An apparatus for placing electrical components upon a substrate. The apparatus is provided with a fitting head and at least one gripper, and the fitting head has a storage element which can be successively filled with the electrical components. The fitting head first moves over the substrate, then the gripper successively removes components from the storage element and places then onto the substrate in a proper

location. The apparatus offers shortened movement paths, and fitting performance is increased. - -

REMARKS

A substitute specification and an Abstract of the Disclosure are provided herewith which make editorial changes in order to conform to standard US practice. A marked-up copy of the specification is also provided reflecting the changes made.

In addition, the claims as filed have been canceled and replaced by new claims that more clearly set forth the subject matter of Applicants' invention.

No new matter has been inserted into the application.

Applicants submit that this application is in proper condition for examination in the United States National Examination Stage, which action is earnestly solicited.

Respectfully submitted,

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09/913311
Rec'd PCT/PTO 10 AUG 2001

Substitute Specification:

--APPARATUS FOR EQUIPPING SUBSTRATES WITH ELECTRICAL COMPONENTS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to apparatuses for equipping substrates with electrical components. In particular, the present invention relates to apparatuses using a moveable equipping head for handling electrical components.

Discussion of the Related Art

Basic devices of this type have been generally disclosed. For example, in US 4,875,285, a turret-like equipping head has a large number of grippers constructed as suction pipettes, which picks up components at the feed locations. From there, the equipping head moves to a printed circuit board which is fixed in the apparatus and onto which the components are placed successively. In this case, the number of components transported is restricted to the number of suction pipettes. After the placement action, the equipping head must be moved again to the feed devices arranged outside the equipping area.

It is notable that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space, and such turret heads usually have only one gripper with which only one large component can be transported in each case.

SUMMARY OF THE INVENTION

The present invention is based on the object of increasing the equipping performance with a low constructional outlay.

This object is achieved by the equipping head with a storage element according to the present invention. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the equipping head in the area of the feed devices picks up components until the storage element has been filled. Then, the equipping head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the proper locations. An equipping head of this type needs only a single gripper for filling and emptying the storage element. Since, only low relative movements take place between the gripper and the storage element, these operations are able to proceed quickly, similar to that in the turret head.

In mechanical terms, the storage element can be configured more simply than the grippers of the turret head. In addition, the storage element can be kept so large that it accommodates a considerably larger number of components, as a result of which the equipping head has to move less often between the feed devices and the substrate.

In one embodiment, the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as provided in a further embodiment provides an easy relative movement of the gripper between the placement and the transfer position.

In another embodiment, the component can easily be fetched from the feed devices, transferred to the storage element, removed from the latter, and placed onto the substrate.

In a further embodiment, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

In another embodiment, the action of positioning the components is simplified. It is possible to use a sensing device, for example an optical sensing device, to determine the position of the components to one of the stepping positions. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

Also, suction openings can be provided with the sliding part so as to constitute simple holding means for the components on the sliding part. This provides a way for the components to be held and transferred on the sliding part in a simple way. The sliding part can also be provided in the form of annular design being rotatably mounted, which readily permits vertical placement of the components onto the storage spaces or onto the substrate.

Accordingly, the operations of fetching components from the feed devices and filling the storage element can be accelerated, in that in each case, one of the grippers is located in the fetch position and another gripper is located in the transfer position. In the same way, the actions of emptying the storage element and equipping the substrate are also accelerated.

In another embodiment, two grippers in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is concentric with the placement position, this can be implemented in a

straightforward manner by the two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

In another embodiment, the pivoting part can be indexed in a rotational movement without any change of direction. Since, the grippers are no longer primarily used for storing the components, the number of grippers can be reduced to the number of working stations provided without any loss in performance. If, in addition to a placement station and a transfer station, a sensing and a rotation station are further provided, only four grippers would be needed.

In another embodiment, the working stations are being provided along a circulation path of the grippers, on a stator of the equipping head. Here, at least one of the working stations form the transfer station. Accordingly, components can be transferred at the clock rate of the equipping head without any loss of time.

By placing a sensing station between the transfer station and the placement station, it is possible to perform positional control and position correction of the components following removal from the storage element, and directly before the last handling step of the placement onto the substrate.

By using an additional storage element, storage capacity can be increased considerably. In the case of a turret-like equipping head, it is easily possible to assign a second transfer station to a previously unused holding station.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows in schematic form an equipping head having two grippers;

Figure 2 shows the equipping head according to figure 1 in a different working phase;

Figure 3 shows a side view of an equipping head with grippers arranged in a turret; and

Figure 4 shows an end view of the equipping head according to Figure 3.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figure 1, an equipping head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), between feed devices and a substrate. Feed devices of this type have, mutually parallel component tapes 2, having pockets in which electronic components 3 are held. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which a respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, by suction.

Gripper 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper 4. By means of withdrawing the gripper 4, the component 3 is removed from the component tape and lifted into the transport position illustrated in Fig. 1.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with

respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the equipping head 1 has an annular storage element 7 which is concentric with the vertical gripper 4, and is provided with an annular sliding part 8 mounted on a stationary annular part 9 of the storage element 7, such that it can be rotated in the direction of rotation arrow D. A free inner side of the sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. Suction openings 10 define storage spaces 11 for the components 3.

Pivoting part 5 can be pivoted between stops 12 belonging to the equipping head 1 in such a way that in each case, one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position in which it is assigned to a transfer station 19 of the equipping head 1. At the same time, the sliding part 8 is rotated into a position assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19. Gripper 4 is oriented perpendicular to the storage space 11. By means of a vertical placement movement of gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8.

During these transfer operations, pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way, that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, and the other gripper 4 is moved into a different transfer position, in which it is assigned to a further transfer station 19 located diametrically opposite the

other. Sliding part 8 is cycled in such a way that in each case, one of the storage spaces 11 is located in the transfer station 19, and the storage element 7 is already completely filled after half a revolution of the sliding part 8.

Then, according to Figure 2, the equipping head 1 can be moved in an equipping area of the equipping apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for filling, is removed successively from the storage element 7 and placed onto the substrate 13.

According to Figures 3 and 4, a large number of grippers 14 are arranged on a rotor 15 mounted on a stator 16 of another equipping head 17, such that it can be rotated step by step. Various angular positions of the grippers 14 are associated with different working stations. These are, constructed as a placement station 18, a transfer station 19, a sensing station 20, and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8 on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle such components may be less suitable for intermediate storage in the storage element 7than the components 3 previously considered.

Equipping head 17 then moves until it is in a position above the substrate 13 to be fitted, as shown in Figure 4. Here, the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by

rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor 15.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation the station 21, place said components 3 onto the substrate 13. After all the components 3 have been placed onto the substrate 13, equipping head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide the equipping head 17, with at least one further storage element 7 and one further transfer station, as indicated by dash-dotted line in Figure 4. Thus, the storage capacity of the equipping head 17 can be increased appropriately.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--

~~Description~~ **Substitute Specification:**

~~Apparatus for fitting~~**--APPARATUS FOR EQUIPPING SUBSTRATES WITH ELECTRICAL COMPONENTS**

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to apparatuses for equipping substrates with electrical components**. In particular, the present** ~~The~~ invention relates to ~~an apparatus for fitting substrates with electrical components by means of a moveable fitting head for handling the components, which can be picked up at feed devices by at least one gripper belonging to the fittinghead, transported to fittinglocations on the substrate and placedonto the substrate ther~~ **apparatuses using a moveable equipping head for handling electrical components.**

~~A device of his type has been disclosed, for example, US4,875,285. A fitting head like a turret~~ **Discussion of the Related Art**

Basic devices of this type have been generally disclosed. For example, in US 4,875,285, a turret-like equipping head has a large number of grippers constructed as suction pipettes, which ~~pick~~ **picks** up ~~the~~ components at the feed ~~devices~~ **locations**. From there, the ~~fitting~~ **equipping** head moves to a printed circuit board which is fixed in the ~~appratus~~ **apparatus** and onto which the components are placed successively. In this case, the number of components transported is restricted ~~tothe~~ **to the** number of suction pipettes. After the placement action, the ~~fitting~~ **equipping** head must be moved again to the feed devices arranged outside the ~~fitting~~ **equipping** area.

It is ~~particularly the case~~ **notable** that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space~~. Provided for such components are heads having~~**, and such turret heads usually have** only one gripper~~,~~ with which only one **large** component can be transported in each case.

SUMMARY OF THE INVENTION

The present ~~The~~ invention is based on the object of increasing the ~~fitting~~ **equipping** performance with a low constructional outlay.

This object is achieved by the ~~invention in accordance with claim 1~~ **equipping head with a storage element according to the present invention**. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the ~~fitting~~ **equipping** head in the area of the feed devices **picks** ~~will pick~~ up components until the storage element has been filled. Then, the ~~fitting~~ **equipping** head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the ~~envisaged fitting~~ **proper** locations. ~~A fitting~~ **An equipping** head of this type needs only a single gripper for filling and emptying the storage element. Since, ~~in this case,~~ only low relative movements take place between the gripper and the storage element, these operations are able to proceed ~~at a high clock rate~~ **quickly**, similar to that in the turret head.

In mechanical terms, the storage element can be configured ~~largely~~ more simply than the grippers of the turret head. In addition, ~~it~~ **the storage element** can be kept so large that it accommodates a considerably larger number of components, as a result of which the ~~fitting~~ **equipping** head has to move less often between the feed devices and the substrate.

~~Advantageous developments of the invention are identified in claims 2 to 18:~~

~~The development as claimed in claim 2 means that~~ **In one embodiment,** the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as ~~claimed in claim 3 means that the~~ **provided in a further embodiment provides an easy** relative movement of the gripper between the placement and the transfer position ~~can be implemented in a simple way.~~.

~~As a result of the development as claimed in claims 4 and 5, the component can be fetched in a simple way~~ **In another embodiment, the component can easily be fetched** from the feed devices, transferred to the storage element, removed from the latter, and placed onto the substrate.

~~As a result of the development as claimed in claim 6~~ **In a further embodiment**, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

~~As a result of the development as claimed in claim 7~~ **In another embodiment**, the action of positioning the components ~~on the sliding part~~ is simplified. It is possible to ~~assign~~ **use** a sensing device, for example an optical sensing device, ~~for determining~~ **to determine** the position of the components to one of the stepping positions ~~of the sliding part~~. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

~~The~~ **Also,** suction openings ~~as claimed in claim 8~~ **can be provided with the sliding part so as to** constitute simple holding means for the components on the sliding part. **This provides a way for** ~~The developments as claimed in claims 9 and~~

~~10 mean that~~ the components ~~can~~ **to** be held and transferred on the sliding part in a simple way.

The **sliding part can also be provided in the form of annular design being rotatably mounted, which readily permits** ~~annular sliding part as claimed in claim 11 constitutes a structural part which is simple and simple to operate.~~

~~The arrangement as claimed in claim 12 readily permits the~~ vertical placement of the components onto the storage spaces or onto the substrate.

~~As a result of the development as claimed in claim 13, the alternating operations when fetching the~~ **Accordingly, the operations of fetching** components from the feed devices and ~~when~~ filling the storage element can be accelerated, in that in each case, one of the grippers is located in the fetch position and another **gripper is located** in the transfer position. In the same way, the actions of emptying the storage element and ~~fitting~~ **equipping** the substrate ~~can be~~ **are also** accelerated.

~~The pivoting part as claimed in claim 14 needs only~~ **In another embodiment,** two grippers~~, which,~~ in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is concentric with the placement position, this can be implemented in a straightforward manner by the two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

~~The rotor as claimed in claim 15 means that~~ **In another embodiment,** the pivoting part can be indexed in a rotational movement without any change of direction. Since, ~~then,~~ the grippers are no longer primarily used for storing the components, ~~their~~ **the** number **of grippers** can be reduced to the number of working stations provided without any ~~costs~~ **loss** in ~~terms of~~ performance. If, ~~for example,~~ in addition to ~~the~~ **a** placement station and ~~to the~~ **a** transfer station, a sensing and a rotation station are further provided, only four grippers ~~are then needed.~~ **would be needed.**

~~As a result of the development as claimed in claim 16, the components are~~ **In another embodiment, the working stations are being provided along a circulation path of the grippers, on a stator of the equipping head. Here, at least one of the working stations form the transfer station. Accordingly, components can be** transferred at the clock rate of the ~~fitting~~ **equipping** head without any loss of time.

~~The arrangement as claimed in claim 17 makes it~~ **By placing a sensing station between the transfer station and the placement station, it is** possible to perform ~~the~~ positional control and position correction of the components following removal from the storage element, and directly before the last handling step of the placement onto the substrate.

By ~~means of the~~ **using an** additional storage element ~~as claimed in claim 18,~~ ~~the,~~ storage capacity can be increased considerably. In the case of a turret-like ~~fitting~~ **equipping** head, it is easily possible to assign ~~the~~ **a** second transfer station to a previously unused holding station.

~~In the following text, the invention will be explained in more detail using an exemplary embodiment illustrated in the drawing, in which:~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 shows in schematic form ~~a fitting~~ **an equipping** head having two grippers ~~in a V shape in relation to each other,~~;

Figure 2 shows the ~~fitting~~ **equipping** head according to figure 1 in a different working phase~~,~~;

Figure 3 shows ~~in schematic form~~ a side view of ~~another fitting~~ **an equipping** head with grippers arranged in ~~the manner of~~ a turret~~,~~; and

Figure 4 shows an end view of the ~~fitting head according to figure 3.~~ **equipping head according to Figure 3.**

~~According to figure 1, a fitting~~ **BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS**

As shown in Figure 1, an equipping head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), ~~for example~~ between feed devices and a substrate. Feed devices of this type have, ~~for example,~~ mutually parallel component tapes 2, having pockets in which electronic components 3 are ~~accommodated~~ **held**. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which ~~the~~ **a** respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, ~~for example by means of~~ **by** suction.

~~The gripper~~ **Gripper** 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper **4**. By means of withdrawing the gripper **4**, the component 3 is removed from the component tape and lifted into the transport position illustrated **in Fig. 1**.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the ~~fitting~~ **equipping** head 1 has an annular storage element 7~~,~~ which is concentric with the vertical gripper 4, and is provided with an annular sliding part 8~~, which is~~ mounted on a stationary annular part 9 of the storage element 7, such that it can be rotated in the direction of rotation arrow D. A free inner side of the sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. ~~These suction~~ **Suction** openings 10 define storage spaces 11 for the components 3.

~~The pivoting~~ **Pivoting** part 5 can be pivoted between stops 12 belonging to the ~~fitting~~ **equipping** head 1 in such a way that in each case, one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position~~,~~ in which it is assigned to a transfer station 19 of the ~~fitting~~ **equipping** head 1. At the same time, the sliding part 8 is rotated into a position ~~in which it is~~

assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19~~, the gripper 4 being~~. **Gripper 4 is** oriented perpendicular to the storage space 11. By means of a vertical placement movement of ~~the~~ gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8.

_____During these transfer operations, ~~the~~ pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way, that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, **and** the other gripper 4 ~~moving~~ **is moved** into a different transfer position, in which it is assigned to a further transfer station 19~~, which is~~ located diametrically opposite the other. ~~The sliding~~ **Sliding** part 8 is cycled in such a way that in each case, one of the storage spaces 11 is located in the transfer station 19, **and** the storage element 7 **is** already ~~having been~~ completely filled after half a revolution of the sliding part 8.

Then, according to ~~figure~~ **Figure** 2, the ~~fitting~~ **equipping** head 1 can be moved in ~~a fitting~~ **an equipping** area of the ~~fitting~~ **equipping** apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for filling, ~~are~~ **is** removed successively from the storage element 7 and placed onto the substrate 13.

According to ~~figures~~ **Figures** 3 and 4, a large number of grippers 14 ~~is~~ **are** arranged on a rotor 15~~, which is~~ mounted on a stator 16 of another ~~fitting~~ **equipping** head 17, such that it can be rotated step by step. Various angular positions of the

grippers 14 are associated with different working stations. These are, ~~for example,~~ constructed as a placement station 18, a transfer station 19, a sensing station 20, and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, ~~the~~ grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle, ~~those~~ **such** components ~~which are~~ **may be** less suitable for intermediate storage in the storage element ~~7 being those considered in particular.~~ **7than the components 3 previously considered.**

~~The fitting~~ **Equipping** head 17 then moves until it is **in a position** above the substrate 13 to be fitted, ~~into the position~~ **as** shown in ~~figure~~ **Figure** 4. Here, ~~first of all~~ the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor **15**.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove ~~the~~ components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation **the**

grippers 14 are associated with different working stations. These are, ~~for example,~~ constructed as a placement station 18, a transfer station 19, a sensing station 20, and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, ~~the~~ grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle~~, those~~ **such** components ~~which are~~ **may be** less suitable for intermediate storage in the storage element ~~7 being those considered in particular.~~ **7than the components 3 previously considered.**

~~The fitting~~ **Equipping** head 17 then moves until it is **in a position** above the substrate 13 to be fitted, ~~into the position~~ **as** shown in ~~figure~~ **Figure** 4. Here, ~~first of all~~ the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor **15**.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove ~~the~~ components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation **the**

station 21, ~~likewise~~ place said components **3** onto the substrate 13. After all the components 3 have been placed onto the substrate 13, **equipping** ~~the fitting~~ head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide~~, in~~ the ~~fitting~~ **equipping** head 17, **with** at least one further storage element 7 and one further transfer station, as indicated **by** dash-dotted **line** in ~~figure~~ **Figure** 4. ~~By this means~~ **Thus**, the storage capacity of the ~~fitting~~ **equipping** head 17 can be increased appropriately.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--

AMENDED APPLICATION FOR THE NATIONAL/REGIONAL PHASE

Description

Apparatus for fitting substrates with electrical components

The invention relates to an apparatus for fitting substrates with electrical components by means of a moveable fitting head for handling the components, which can be picked up at feed devices by at least one gripper belonging to the fitting head, transported to fitting locations on the substrate and placed onto the substrate there.

A device of this type has been disclosed, for example, by US 4,875,285. A fitting head like a turret head has a large number of grippers constructed as suction pipettes, which pick up the components at the feed devices. From there, the fitting head moves to a printed circuit board which is fixed in the apparatus and onto which the components are placed successively. In this case, the number of components transported is restricted to the number of suction pipettes. After the placement action, the fitting head must be moved again to the feed devices arranged outside the fitting area.

It is particularly the case that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space. Provided for such components are heads having only one gripper, with which only one component can be transported in each case.

The invention is based on the object of increasing the fitting performance with a low constructional outlay.

This object is achieved by the invention in accordance with claim 1. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the fitting head in the area of the feed devices will

pick up components until the storage element has been filled. Then,

the fitting head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the envisaged fitting locations. A fitting head of this type needs only a single gripper for filling and emptying the storage element. Since, in this case, only low relative movements take place between the gripper and the storage element, these operations are able to proceed at a high clock rate, similar to that in the turret head.

In mechanical terms, the storage element can be configured largely more simply than the grippers of the turret head. In addition, it can be kept so large that it accommodates a considerably larger number of components, as a result of which the fitting head has to move less often between the feed devices and the substrate.

Advantageous developments of the invention are identified in claims 2 to 18:

The development as claimed in claim 2 means that the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as claimed in claim 3 means that the relative movement of the gripper between the placement and the transfer position can be implemented in a simple way.

As a result of the development as claimed in claims 4 and 5, the component can be fetched in a simple way from the feed devices, transferred to the storage element, removed from the latter and placed onto the substrate.

As a result of the development as claimed in claim 6, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

As a result of the development as claimed in claim 7, the action of positioning the components on the sliding part is simplified. It is possible to assign a sensing device, for example an optical sensing device, for determining the position of the components to one of the stepping positions of the sliding part. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

The suction openings as claimed in claim 8 constitute simple holding means for the components on the sliding part.

The developments as claimed in claims 9 and 10 mean that the components can be held and transferred on the sliding part in a simple way.

The annular sliding part as claimed in claim 11 constitutes a structural part which is simple and simple to operate.

The arrangement as claimed in claim 12 readily permits the vertical placement of the components onto the storage spaces or onto the substrate.

As a result of the development as claimed in claim 13, the alternating operations when fetching the components from the feed devices and when filling the storage element can be accelerated, in that in each case one of the grippers is located in the fetch position and another in the transfer position. In the same way, the actions of emptying the storage element and fitting the substrate can be accelerated.

The pivoting part as claimed in claim 14 needs only two grippers, which, in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is

concentric with the placement position, this can be implemented in a straightforward manner by the

two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

The rotor as claimed in claim 15 means that the pivoting part can be indexed in a rotational movement without any change of direction. Since, then, the grippers are no longer primarily used for storing the components, their number can be reduced to the number of working stations provided without any costs in terms of performance. If, for example, in addition to the placement station and to the transfer station, a sensing and a rotation station are further provided, only four grippers are then needed.

As a result of the development as claimed in claim 16, the components are transferred at the clock rate of the fitting head without any loss of time.

The arrangement as claimed in claim 17 makes it possible to perform the positional control and position correction of the components following removal from the storage element and directly before the last handling step of the placement onto the substrate.

By means of the additional storage element as claimed in claim 18, the storage capacity can be increased considerably. In the case of a turret-like fitting head, it is easily possible to assign the second transfer station to a previously unused holding station.

In the following text, the invention will be explained in more detail using an exemplary embodiment illustrated in the drawing, in which:

Figure 1 shows in schematic form a fitting head having two grippers in a V shape in relation to each other,

Figure 2 shows the fitting head according to figure 1 in a different working phase,

Figure 3 shows in schematic form a side view of another fitting head with grippers arranged in the manner of a turret, and

Figure 4 shows an end view of the fitting head according to figure 3.

According to figure 1, a fitting head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), for example between feed devices and a substrate. Feed devices of this type have, for example, mutually parallel component tapes 2 having pockets in which electronic components 3 are accommodated. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which the respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, for example by means of suction.

The gripper 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper. By means of withdrawing the gripper, the component 3 is removed from the component tape and lifted into the transport position illustrated.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the fitting head 1 has an annular storage element 7, which is concentric with the vertical gripper 4 and is provided with an annular sliding part 8, which is mounted on a stationary

annular part 9 of the storage element 7 such that it can be rotated in the direction of rotation arrow D. A free inner side of the

sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. These suction openings 10 define storage spaces 11 for the components 3.

The pivoting part 5 can be pivoted between stops 12 belonging to the fitting head 1 in such a way that in each case one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position, in which it is assigned to a transfer station 19 of the fitting head 1. At the same time, the sliding part 8 is rotated into a position in which it is assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19, the gripper 4 being oriented perpendicular to the storage space 11. By means of a vertical placement movement of the gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8. During these transfer operations, the pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, the other gripper 4 moving into a different transfer position, in which it is assigned to a further transfer station 19, which is located diametrically opposite the other. The sliding part 8 is cycled in such a way that in each case one of the storage spaces 11 is located in the transfer station 19, the storage element 7 already having been completely filled after half a revolution of the sliding part 8.

Then, according to figure 2, the fitting head 1 can be moved in a fitting area of the fitting apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for

filling, are removed successively from the storage element 7 and placed onto the substrate 13.

According to figures 3 and 4, a large number of grippers 14 is arranged on a rotor 15, which is mounted on a stator 16 of another fitting head 17 such that it can be rotated step by step. Various angular positions of the grippers 14 are associated with different working stations. These are, for example, constructed as a placement station 18, a transfer station 19, a sensing station 20 and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, the grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle, those components which are less suitable for intermediate storage in the storage element 7 being those considered in particular.

The fitting head 17 then moves until it is above the substrate 13 to be fitted, into the position shown in figure 4. Here, first of all the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove the components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation station 21, likewise place said components onto the substrate 13. After all the components 3 have been placed onto the

substrate 13,

the fitting head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide, in the fitting head 17, at least one further storage element 7 and one further transfer station, as indicated dash-dotted in figure 4. By this means, the storage capacity of the fitting head 17 can be increased appropriately.

Patent claims

1. An apparatus for fitting substrates (13) with electrical components (3) by means of a moveable fitting head (1, 17) for handling the components (3), which can be picked up at feed devices by at least one gripper (4, 14) belonging to the fitting head (1, 17), transported to fitting locations on the substrate (13) and placed onto the substrate (13) there, characterized in that the fitting head (1, 17) has at least one storage element (7), separate from the gripper (4, 14) having a plurality of storage spaces (11) for the components (3), in that the gripper (4, 14) and the storage spaces (11) can be moved relative to one another, in that the components (3) picked up by the gripper (4, 14) can be deposited at the storage spaces (11) of the storage element (7), and in that the deposited components (3) can be removed from the storage spaces (11) by means of the gripper (4, 14) and placed onto the substrate (13).

2. The apparatus as claimed in claim 1, characterized in that the components (3) can be fixed at a holding end of the gripper (4, 14), in that the holding end can be moved transversely with respect to the placement direction of the components (3) into a transfer position, which is assigned to a transfer station of the fitting head (1, 17), and in that the storage spaces (11) in the fitting head (1, 17) can be displaced successively to the transfer station.

3. The apparatus as claimed in claim 2, characterized in that the gripper (4, 14) is mounted n a pivoting part (5) of the fitting head (1, 17) and

in that the holding end can be pivoted transversely with respect to the placement direction, by means of the pivoting part, between a placement station and the transfer station.

4. The apparatus as claimed in claim 3, characterized in that the gripper (4, 14) is mounted in a guide in the pivoting part (5), such that it can be displaced longitudinally in the placement direction.

5. The apparatus as claimed in claim 4, characterized in that the holding end in the transfer station (19) can be displaced longitudinally in the direction of the storage space (11) located there.

6. The apparatus as claimed in one of claims 1 to 5, characterized in that the gripper (4, 14) is constructed as a suction gripper and in that the pressure conditions in the gripper (4, 14) in the transfer position can be controlled in such a way that the holding force of the gripper (4, 14) falls above or below the holding force of the storage space (11).

7. The apparatus as claimed in one of claims 2 to 6, characterized in that the storage spaces (11) are distributed in a grid-like fashion on a sliding part (8), which is mounted on the fitting head (1, 17) such that it can be displaced step by step, and in that the storage spaces (11) can be displaced successively to the transfer station.

8. The apparatus as claimed in claim 7, characterized in that the sliding part (8) on the storage spaces (11) is provided with suction openings (10) for the components (3).

9. The apparatus as claimed in claim 8,

characterized in that the suction openings (10) of the storage element (7) are permanently connected to a common suction line.

10. The apparatus as claimed in claim 9, characterized in that the storage element (7) on the transfer station is provided with means for changing over the pressure in the suction opening (10).

11. The apparatus as claimed in one of claims 7 to 10, characterized in that the sliding part (8) is of annular design and rotatably mounted.

12. The apparatus as claimed in claim 11, characterized in that the axis of rotation of the sliding part (8) is congruent with the longitudinal axis of the gripper (4, 14) located in the placement position, and in that the storage spaces (11) for the components (3) have supporting surfaces which extend perpendicular to the longitudinal axis of the gripper (4, 14) located in the transfer position.

13. The apparatus as claimed in one of the preceding claims, characterized in that the pivoting part (5) is provided with a plurality of guides for a plurality of the grippers (4, 14), which can be pivoted successively into the transfer position.

14. The apparatus as claimed in claim 13, characterized in that in the pivoting part (5), two grippers (4) are provided which have longitudinal axes in a V shape with respect to each other in a pivoting plane, and

in that the grippers (4) can be pivoted alternately into the placement position, in which the respective other gripper (4) is located in the transfer position.

15. The apparatus as claimed in claim 13, characterized in that the pivoting part is constructed as a turret-like rotor (15) having a multiplicity of circularly arranged grippers (14), and in that the rotor (15) can be driven and indexed in accordance with the angular pitch of the grippers (14).

16. The apparatus as claimed in claim 15, characterized in that working stations are provided along a circulation path of the grippers (14), on a stator (16) of the fitting head (17), and in that at least one of the working stations forms the transfer station (19).

17. The apparatus as claimed in claim 16, characterized in that in the direction of rotation of the rotor (15), between the transfer station (19) and the placement station (18), there are arranged a sensing station (20) for determining the position of the components (3) and a rotation station (21) for the components (3).

18. The apparatus as claimed in one of the preceding claims, characterized in that the fitting head (17) has at least one further storage element (7), which is assigned at least one further transfer station.

Description

Apparatus for fitting substrates with electrical components

The invention relates to an apparatus for fitting substrates with electrical components by means of a moveable fitting head for handling the components, which can be picked up at feed devices by at least one gripper belonging to the fitting head, transported to fitting locations on the substrate and placed onto the substrate there.

A device of this type has been disclosed, for example, by US 4,875,285. A fitting head like a turret head has a large number of grippers constructed as suction pipettes, which pick up the components at the feed devices. From there, the fitting head moves to a printed circuit board which is fixed in the apparatus and onto which the components are placed successively. In this case, the number of components transported is restricted to the number of suction pipettes. After the placement action, the fitting head must be moved again to the feed devices arranged outside the fitting area.

It is particularly the case that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space. Provided for such components are heads having only one gripper, with which only one component can be transported in each case.

The invention is based on the object of increasing the fitting performance with a low constructional outlay.

This object is achieved by the invention in accordance with claim 1. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the fitting head in the area of the feed devices will pick up components until the storage element has been filled. Then,

the fitting head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the envisaged fitting locations. A fitting head of this type needs only a single gripper for filling and emptying the storage element. Since, in this case, only low relative movements take place between the gripper and the storage element, these operations are able to proceed at a high clock rate, similar to that in the turret head.

In mechanical terms, the storage element can be configured largely more simply than the grippers of the turret head. In addition, it can be kept so large that it accommodates a considerably larger number of components, as a result of which the fitting head has to move less often between the feed devices and the substrate.

Advantageous developments of the invention are identified in claims 2 to 18:

The development as claimed in claim 2 means that the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as claimed in claim 3 means that the relative movement of the gripper between the placement and the transfer position can be implemented in a simple way.

As a result of the development as claimed in claims 4 and 5, the component can be fetched in a simple way from the feed devices, transferred to the storage element, removed from the latter and placed onto the substrate.

As a result of the development as claimed in claim 6, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

As a result of the development as claimed in claim 7, the action of positioning the components on the sliding part is simplified. It is possible to assign a sensing device, for example an optical sensing device, for determining the position of the components to one of the stepping positions of the sliding part. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

The suction openings as claimed in claim 8 constitute simple holding means for the components on the sliding part.

The developments as claimed in claims 9 and 10 mean that the components can be held and transferred on the sliding part in a simple way.

The annular sliding part as claimed in claim 11 constitutes a structural part which is simple and simple to operate.

The arrangement as claimed in claim 12 readily permits the vertical placement of the components onto the storage spaces or onto the substrate.

As a result of the development as claimed in claim 13, the alternating operations when fetching the components from the feed devices and when filling the storage element can be accelerated, in that in each case one of the grippers is located in the fetch position and another in the transfer position. In the same way, the actions of emptying the storage element and fitting the substrate can be accelerated.

The pivoting part as claimed in claim 14 needs only two grippers, which, in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is

concentric with the placement position, this can be implemented in a straightforward manner by the

two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

The rotor as claimed in claim 15 means that the pivoting part can be indexed in a rotational movement without any change of direction. Since, then, the grippers are no longer primarily used for storing the components, their number can be reduced to the number of working stations provided without any costs in terms of performance. If, for example, in addition to the placement station and to the transfer station, a sensing and a rotation station are further provided, only four grippers are then needed.

As a result of the development as claimed in claim 16, the components are transferred at the clock rate of the fitting head without any loss of time.

The arrangement as claimed in claim 17 makes it possible to perform the positional control and position correction of the components following removal from the storage element and directly before the last handling step of the placement onto the substrate.

By means of the additional storage element as claimed in claim 18, the storage capacity can be increased considerably. In the case of a turret-like fitting head, it is easily possible to assign the second transfer station to a previously unused holding station.

In the following text, the invention will be explained in more detail using an exemplary embodiment illustrated in the drawing, in which:

Figure 1 shows in schematic form a fitting head having two grippers in a V shape in relation to each other,

Figure 2 shows the fitting head according to figure 1 in a different working phase,

Figure 3 shows in schematic form a side view of another fitting head with grippers arranged in the manner of a turret, and

Figure 4 shows an end view of the fitting head according to figure 3.

According to figure 1, a fitting head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), for example between feed devices and a substrate. Feed devices of this type have, for example, mutually parallel component tapes 2 having pockets in which electronic components 3 are accommodated. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which the respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, for example by means of suction.

The gripper 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper. By means of withdrawing the gripper, the component 3 is removed from the component tape and lifted into the transport position illustrated.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the fitting head 1 has an annular storage element 7, which is concentric with the vertical gripper 4 and is provided with an annular sliding part 8, which is mounted on a stationary

annular part 9 of the storage element 7 such that it can be rotated in the direction of rotation arrow D. A free inner side of the

sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. These suction openings 10 define storage spaces 11 for the components 3.

The pivoting part 5 can be pivoted between stops 12 belonging to the fitting head 1 in such a way that in each case one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position, in which it is assigned to a transfer station 19 of the fitting head 1. At the same time, the sliding part 8 is rotated into a position in which it is assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19, the gripper 4 being oriented perpendicular to the storage space 11. By means of a vertical placement movement of the gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8. During these transfer operations, the pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, the other gripper 4 moving into a different transfer position, in which it is assigned to a further transfer station 19, which is located diametrically opposite the other. The sliding part 8 is cycled in such a way that in each case one of the storage spaces 11 is located in the transfer station 19, the storage element 7 already having been completely filled after half a revolution of the sliding part 8.

Then, according to figure 2, the fitting head 1 can be moved in a fitting area of the fitting apparatus above a substrate 13, onto which the component 3, in a

movement sequence which is the reverse of that fo
r

filling, are removed successively from the storage element 7 and placed onto the substrate 13.

According to figures 3 and 4, a large number of grippers 14 is arranged on a rotor 15, which is mounted on a stator 16 of another fitting head 17 such that it can be rotated step by step. Various angular positions of the grippers 14 are associated with different working stations. These are, for example, constructed as a placement station 18, a transfer station 19, a sensing station 20 and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, the grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle, those components which are less suitable for intermediate storage in the storage element 7 being those considered in particular.

The fitting head 17 then moves until it is above the substrate 13 to be fitted, into the position shown in figure 4. Here, first of all the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove the components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation station 21, likewise place said components onto the substrate 13. After all the components 3 have been placed onto the

substrate 13,

the fitting head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide, in the fitting head 17, at least one further storage element 7 and one further transfer station, as indicated dash-dotted in figure 4. By this means, the storage capacity of the fitting head 17 can be increased appropriately.

Patent claims

1. An apparatus for fitting substrates (13) with electrical components (3) by means of a moveable fitting head (1, 17) for handling the components (3), which can be picked up at feed devices (e.g. 2) by at least one gripper (4, 14) belonging to the fitting head (1, 17), transported to fitting locations on the substrate (13) and placed onto the substrate (13) there, characterized in that the fitting head (1, 17) is assigned at least one storage element (7), separate from the gripper (4, 14) having a plurality of storage spaces (11) for the components (3), in that the gripper (4, 14) and the storage spaces (11) can be moved relative to one another, in that the components (3) picked up by the gripper (4, 14) can be deposited at the storage spaces (11) of the storage element (7), and in that the deposited components (3) can be removed from the storage spaces (11) by means of the gripper (4, 14) and placed onto the substrate (13).

2. The apparatus as claimed in claim 1, characterized in that the components (3) can be fixed at a holding end of the gripper (4, 14), in that the holding end can be moved transversely with respect to the placement direction of the components (3) into a transfer position, which is assigned to a transfer station of the fitting head (1, 17), and in that the storage spaces (11) in the fitting head (1, 17) can be displaced successively to the transfer station.

3. The apparatus as claimed in claim 2, characterized in that the gripper (4, 14) is mounted n a pivoting part (5, e.g. 15) of the fitting head (1, 17) and

in that the holding end can be pivoted transversely with respect to the placement direction, by means of the pivoting part, between a placement station and the transfer station.

4. The apparatus as claimed in claim 3, characterized in that the gripper (4, 14) is mounted in a guide in the pivoting part (5, e.g. 15), such that it can be displaced longitudinally in the placement direction.

5. The apparatus as claimed in claim 4, characterized in that the holding end in the transfer station (19) can be displaced longitudinally in the direction of the storage space (11) located there.

6. The apparatus as claimed in one of claims 1 to 5, characterized in that the gripper (4, 14) is constructed as a suction gripper and in that the pressure conditions in the gripper (4, 14) in the transfer position can be controlled in such a way that the holding force of the gripper (4, 14) falls above or below the holding force of the storage space (11).

7. The apparatus as claimed in one of claims 2 to 6, characterized in that the storage spaces (11) are distributed in a grid-like fashion on a sliding part (8), which is mounted on the fitting head (1, 17) such that it can be displaced step by step, and in that the storage spaces (11) can be displaced successively to the transfer station.

8. The apparatus as claimed in claim 7, characterized in that the sliding part (8) on the storage spaces (11) is provided with suction openings (10) for the components (3).

9. The apparatus as claimed in claim 8, characterized in that the suction openings (10) of the storage element (7) are permanently connected to a common suction line.

10. The apparatus as claimed in claim 9, characterized in that the storage element (7) on the transfer station is provided with means for changing over the pressure in the suction opening (10).

11. The apparatus as claimed in one of claims 7 to 10, characterized in that the sliding part (8) is of annular design and rotatably mounted.

12. The apparatus as claimed in claim 11, characterized in that the axis of rotation of the sliding part (8) is congruent with the longitudinal axis of the gripper (4, 14) located in the placement position, and in that the storage spaces (11) for the components (3) have supporting surfaces which extend perpendicular to the longitudinal axis of the gripper (4, 14) located in the transfer position.

13. The apparatus as claimed in one of the preceding claims, characterized in that the pivoting part (5, e.g. 15) is provided with a plurality of guides for a plurality of the grippers (4, 14), which can be pivoted successively into the transfer position.

14. The apparatus as claimed in claim 13, characterized in that in the pivoting part (5), two grippers (4) are provided which have longitudinal axes in a V shape with respect to each other in a pivoting plane, and

in that the grippers (4) can be pivoted alternately into the placement position, in which the respective other gripper (4) is located in the transfer position.

15. The apparatus as claimed in claim 13, characterized in that the pivoting part is constructed as a turret-like rotor (15) having a multiplicity of circularly arranged grippers (14), and in that the rotor (15) can be driven and indexed in accordance with the angular pitch of the grippers (14).

16. The apparatus as claimed in claim 15, characterized in that working stations are provided along a circulation path of the grippers (14), on a stator (16) of the fitting head (17), and in that at least one of the working stations forms the transfer station (19).

17. The apparatus as claimed in claim 16, characterized in that in the direction of rotation of the rotor (15), between the transfer station (19) and the placement station (18), there are arranged a sensing station (20) for determining the position of the components (3) and a rotation station (21) for the components (3).

18. The apparatus as claimed in one of the preceding claims, characterized in that the fitting head (17) has at least one further storage element (7), which is assigned at least one further transfer station.

Abstract

Apparatus for fitting substrates with electrical components

A fitting head (1, 17) belonging to the apparatus is provided with a storage element (7) which can be successively filled with components (3) by means of a gripper (4, 14). The fitting head (1, 15) then moves over a substrate (13) to be fitted, the gripper (4, 14) removing the components (3) successively from the storage element (7) and placing them onto the substrate (13).

As a result, the movement paths are shortened and the fitting performance increased.

Figure 1

Abstract

Apparatus for fitting substrates with electrical components

A fitting head (1, 17) belonging to the apparatus is provided with a storage element (7) which can be successively filled with components (3) by means of a gripper (4, 14). The fitting head (1, 15) then moves over a substrate (13) to be fitted, the gripper (4, 14) removing the components (3) successively from the storage element (7) and placing them onto the substrate (13).

As a result, the movement paths are shortened and the fitting performance increased.

Figure 1

BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY – CHAPTER II

SUBMISSION OF DRAWINGS

APPLICANT(S):	SCHULZ, R., et al.
ATTORNEY DOCKET NO:	P01,0114
INTERNATIONAL APPLICATION NO:	PCT/DE00/00314
INTERNATIONAL FILING DATE:	02 FEB 2000
INVENTION:	DEVICE FOR FITTING SUBSTRATES WITH ELECTRICAL COMPONENTS

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Applicants herewith submit two drawing sheets, showing Figure 1 – 4, in the captioned PCT application.

Respectfully submitted,

Steven H. Noll (Reg. No. 28,982)

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FIG 1

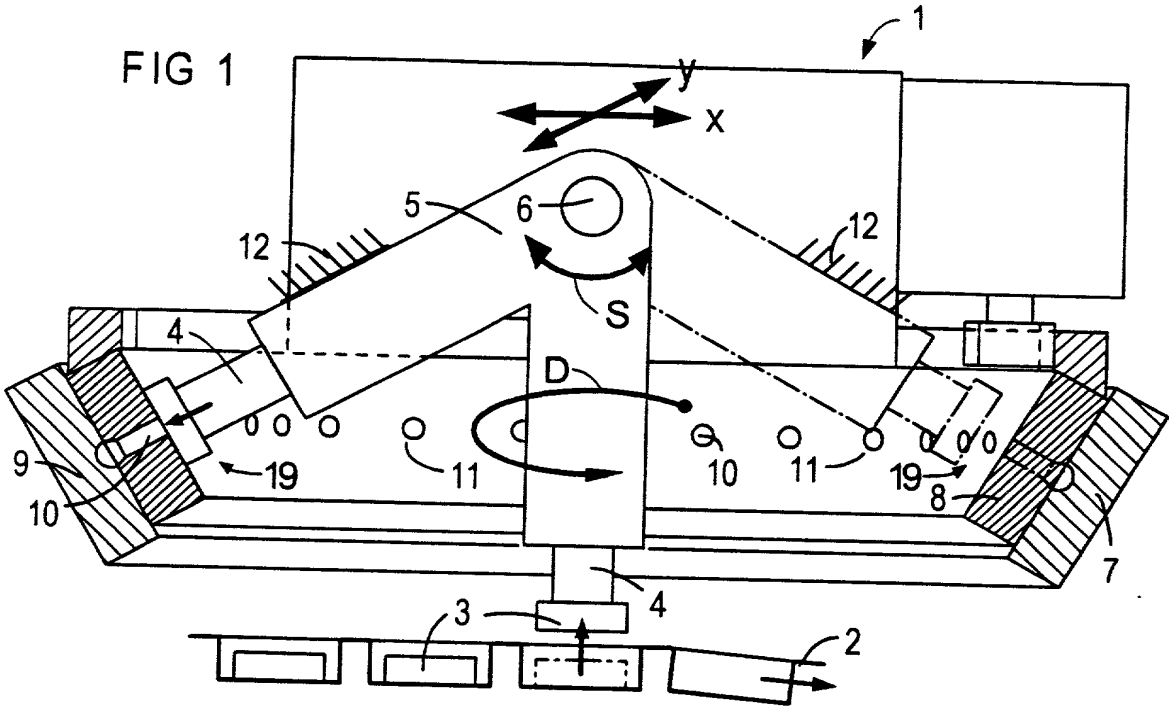


FIG 2

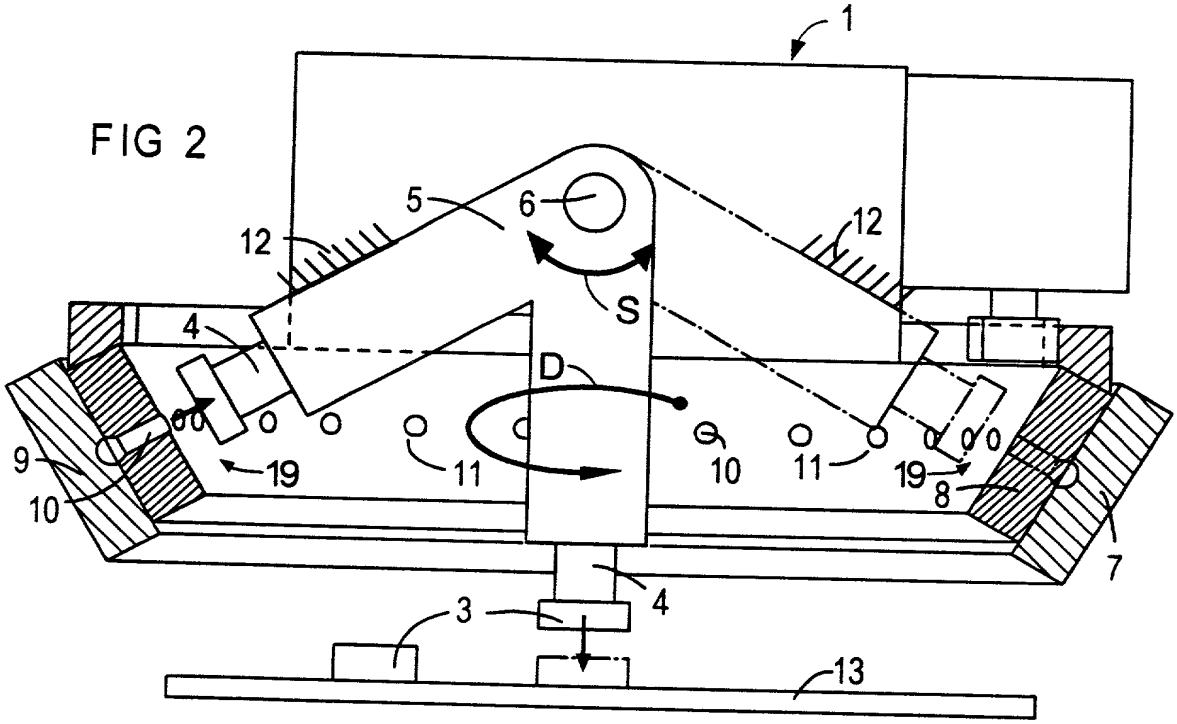


FIG 4

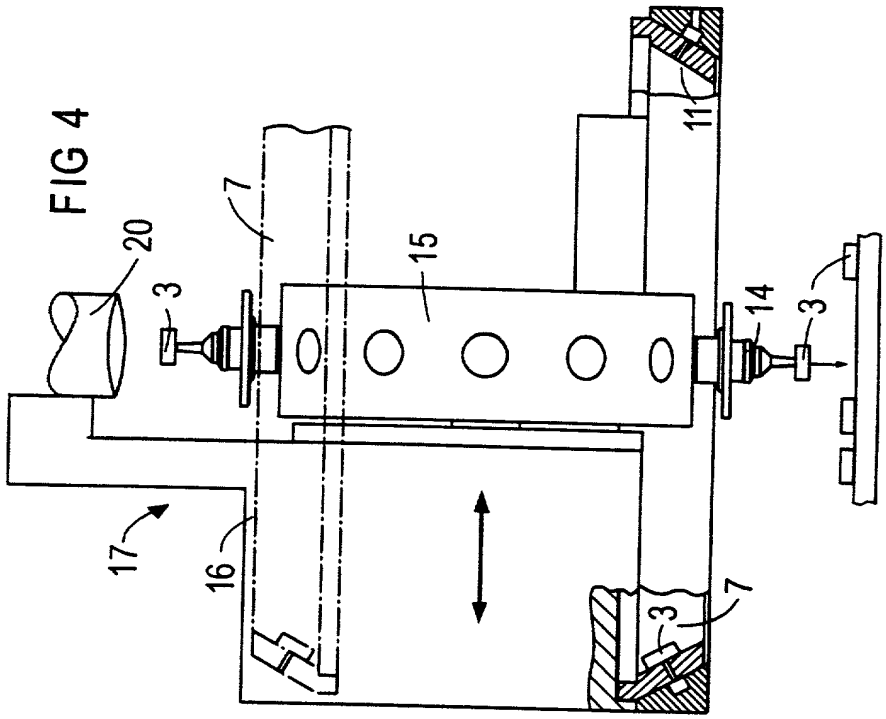
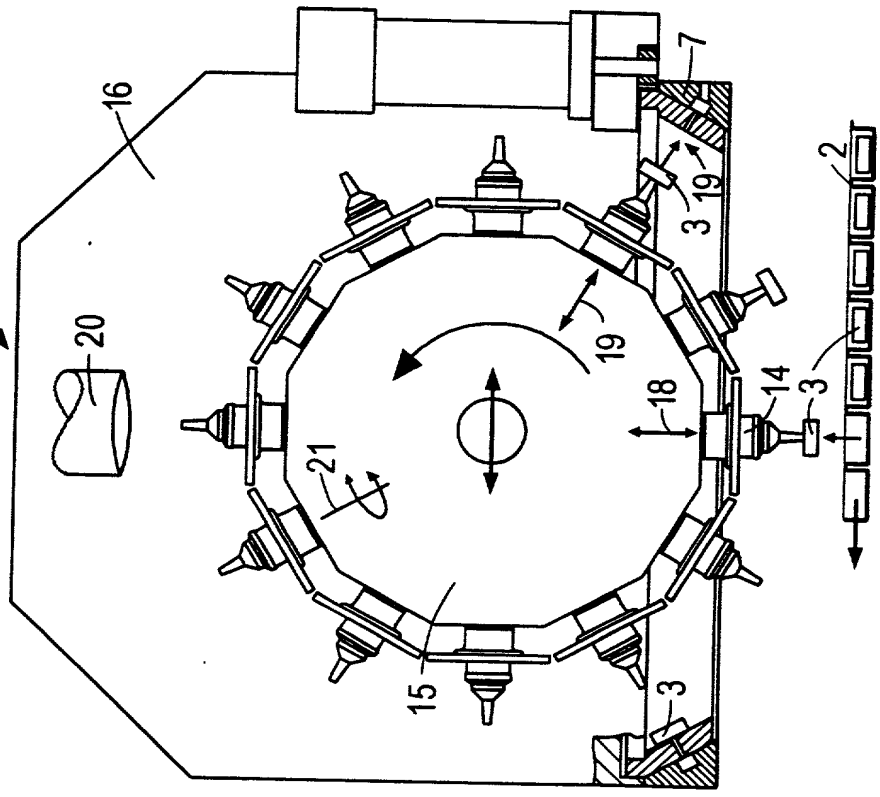


FIG 3



Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Vorrichtung zum Bestuecken von Substraten mit elektrischen Bauelementen

Device for fitting substrates with electrical components

deren Beschreibung

the specification of which

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 02.02.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/00314
eingereicht wurde und am _____
abgeändert wurde (falls tatsächlich abgeändert).

(check one)
☐ is attached hereto.
☒ was filed on 02.02.2000 as
PCT international application
PCT Application No. PCT/DE00/00314
and was amended on _____
(if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Priorität beansprucht

			Priority Claimed	
19908206.5	DE	25.02.1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/00314	02.02.2000		
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D, M, Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

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Ext. _____

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Unterschrift des Erfinders Datum	Inventor's signature Date
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Wohnsitz	Residence
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Staatsangehörigkeit	Citizenship
DE	DE
Postanschrift	Post Office Addess
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Unterschrift des Erfinders Datum	Second Inventor's signature Date
Wohnsitz	Residence
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Staatsangehörigkeit	Citizenship
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81241 MUENCHEN	81241 MUENCHEN

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).